INSTRUCTION MANUAL FOR MODEL 123

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MP MASTER
MA23325

OPERATING NOTES

for

NOISE SOURCE MODEL 123

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1. GENERAL INFORMATION

1.1 Specifications

FREQUENCY RANGE:	5 to 250 Mc
EXCESS NOISE:	5.2 dB (used with model 113) 8.5 dB (used with model 117)
Excess Noise correction factor:	+ 0.1 dB at 100 Mc +0.25 dB at 150 Mc +0.4 dB at 200 Mc
SOURCE IMPEDANCE:	
Model 123 A:	50 ohm; VSWR: 1.05 max. 5-150 Mc 1.08 max. 150-200 Mc 1.12 max. 200-250 Mc
Model 123 B:	
Source (parallel) resistance:	390 ohm ± 5 %x)
Source (parallel) capacitance:	25 pF ± 10 %x)

CURRENT:	Model 113; 5.2 dB	Model 117; 8.5 dB
Model 123 A:	3.31 mA	7.08 mA
Model 123 B:	0.424 mA	0.908 mA

OUTPUT CONNECTOR:	BNC, female
INPUT CABLE(power):	1.5 meter, terminated in a MS-3106A-14S-5P connector
NOISE TUBE:	5722
WEIGHT:	400 grams

x) Other impedance available on request.

1.2 General Description

The Model 123 Noise Source consists of a temperature limited diode and its associated circuitry housed in an aluminium container. The Model 123 provides a wide band noise spectrum from 5 to 250 Mc. At rated current and impedance, the source produces an output excess noise as above. The output is unbalanced to ground.

1.3. Uses

The Model 123 Noise Source may be used in the measurement of noise figure of amplifiers and recievers. It is especially useful for aligning such equipment to a minimum noise figure.

1.4. Installation

The Noise Source has been designed to receive power from the 113 Noise Figure Meter. This Noise Source may, however, be operated independently from the noise figure meter.

2. OPERATING INSTRUCTIONS

2.1 General Information

To obtain significant noise figure measurements the impedance which the Noise Source presents to the device under test should be equal to the impedance that the device normally sees during operation.

2.2 Operating Procedures

Figure 3.2 in the Model 113 Instruction Manual shows a typical set-up for noise measurements with Noise Source Model 123.

To make measurements the following procedure is recommended:

1. Connect the Noise Source to the DIODE connector on the Model 113 Noise Figure Meter.

2. Set the Noise Source current to the specified value as shown in the specification.

   For non-standard source impedances the current can be computed from:

Model 113	Model 117
$I = 3.31 \cdot \frac{50}{R}$	$I = 7.08 \cdot \frac{50}{R}$

   where R is the source resistance.

3. Connect the Noise Source to the input of the device under test. Make sure that the impedance simulated by the noise source is the correct impedance for the device under test. For example, when connected to an intermediate frequency amplifier both the R and the C of the source must be correct

4. Connect the output of the device under test to the Noise Figure Meter and read the noise figure on the meter.

2.3 Operation without a Noise Figure Meter

The Model 123 Noise Source can be used for continous (dc) operation. Under this condition power for the Noise Source may be obtained from a circuit similar to that shown in figure 2-1. With the plate voltage applied between $+E_B$ and $-E_B$, the meter, M, will monitor the current through the noise diode.

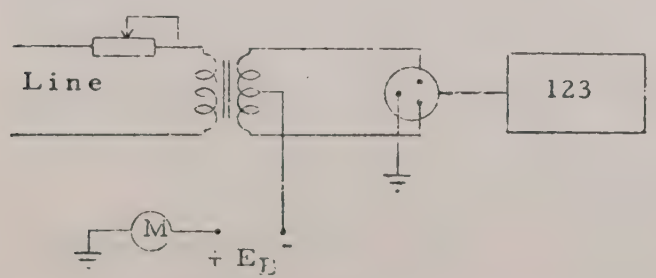


Fig. 2-1. Typical Supply Arrangement for DC Operation of Model 123.

2.4 Accuracy

The noise output of the Noise Source is nominally 5.2 dB. The absolute level of the output, however, depends on several factors; such as diode current, impedance, temperature and resonance effects in the noise diode. These factors must be taken into consideration when absolute measurements are required

For relative measurements, such as those made when seeking to improve the noise figure of an amplifier by changing components or circuitry, satisfactory results will be obtained by using the Noise Figure Meter and the 123 Noise Source without making corrections.

For absolute measurements, where the utmost in accuracy is important, the following factors should be taken into consideration:

2.4.1 Current

The exact value of current through the Noise Source (DIODE) may be computed from:

$$5.2 = 10 \log 20 \times I \times R \text{ (Model 113)}$$

$$8.5 = 10 \log 20 \times I \times R \text{ (Model 117)}$$

where, R = source resistance

I = noise source (DIODE) current

The resistance can be measured with an impedance bridge, which operates in the frequency range of the noise source. Be sure to take into account the accuracy of the measurements made on the bridge, including effects from connectors and cables.

The accuracy of the ammeter monitoring the noise source current is important as the noise output is direct propotional to noise source current. The Noise-Figure-Meter meter-movement is a 1 % meter with a 1 % shunt. If greater accuracy is required, a more accurate external meter may be used to measure the diode current This meter may be connected in series with the center tap of the noise-diode filament-transformer secondary winding.

2.4.2 Temperature

The absolute temperature of the internal source resistor in the 123 will also affect the level of the noise output. After 30 minutes of operation the internal resistor stabilizes at a temperature of 22°C above ambient.

The measured noise figure can be corrected for temperature by the following equation:

$$F = 10 \log \left(\text{antilog} \left(\frac{Fm}{10}\right) - \left(\frac{T}{To} - 1\right) \right)$$

Where: F=actual noise figure Fm= measured noise figure

T=ambient temperature (resistor temperature)

T=reference temperature of 290°K

Temperature correction curves are presented in the Model 113 Instruction Manual. See Figure 3.6.

2.5 Non-Standard Source Impedances

Model 123 A is designed to operate at 50 Ω source impedance, but may be used when the required impedance differs from 50 Ω.

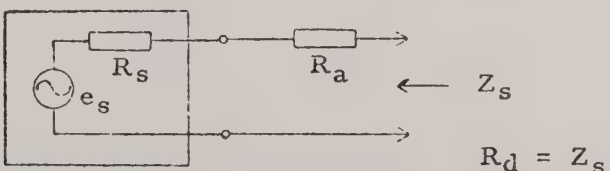
1. For correct measurements make the source impedance equal to the required source impedance of the device under test.

2. Determine a correction factor so the true excess noise is known.

There are two cases to consider: 1) The nominal impedance of the noise source is lower than the desired and 2) the impedance is higher than desired.

2.5.1. Impedance lower than required

To increase the output resistance of the Noise Source, add a resistor in series with the noise source output as:



Model 123 A

Then, $R_a = R_d - R_s$

where Rd is equal to Zs, the source impedance of the device under test. As, Po, the power available from the source at nominal resistance, Rs, is:

$$P_o = \frac{e_s^2}{4R_s}$$

The power available from the noise source when padded to present an output impedance equal to Rd is:

$$P_a = \frac{e_s^2}{4(R_s + R_d)} = \frac{e_s^2}{4R_d}$$

Therefore:

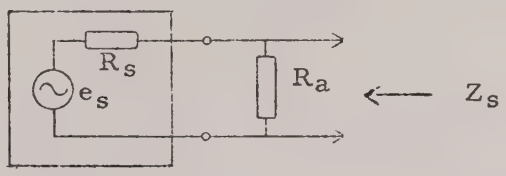
$$\frac{Pa}{Po} = \frac{Rs}{Rd}$$

This means that the excess noise is lower by a factor:

$$10 \log \frac{Rs}{Rd} \quad \text{dB}$$

2.5.2. Impedance higher than required

To decrease the impedance of the 123, add a resistor, Ra, in parallel with the noise source output as:



Model 123 A/B $R_d = Z_s$

Then, $$R_a = \frac{Rs\ Rd}{Rs - Rd}$$

where Rd is equal to Zs, the source impedance of the device under test. As, Po, the power available from the source at nominal resistance, Rs, is:

$$P_o = \frac{e_s^2}{4\ R_s}$$

The power available from the noise source when parallelled to present an output impedance equal to Rd is:

$$P_a = \frac{\left(e_s \frac{Ra}{Ra + Rs}\right)^2}{\frac{4\ Ra\ Rs}{(Ra + Rs)}} = \frac{\left(e_s \frac{Rd}{Rs}\right)^2}{4\ Rd}$$

$$= \frac{e_s^2\ Rd}{4\ R_s^2}$$

Therefore $$\frac{P_a}{P_o} = \frac{R_d}{R_s}$$

This means that the excess noise is lower by a factor:

$$10 \log \frac{Rd}{Rs} \qquad \text{dB}$$

Compensate for this lowering in the excess noise level by:

1. Subtracting the correction from the Noise Figure Meter reading or:
2. Increase the DIODE current by the factor Pa/Po, which will make the Noise Figure Meter direct reading.

3. THEORY OF OPERATION

The Model 123 Noise Source consists of a temperature-limited diode and its associated circuitry housed in an aluminum container. The circuit is shown on Figure 3-1.

Model 123 A is a 50 Ω source designed to operate in 50 Ω systems. The source is unbalanced to ground but may be operated in balanced systems with the aid of a balance-to-unbalance transformer.

Model 123 B has been designed for noise figure measurements of IF amplifiers operating from crystal mixers. It is supplied with a resistance of 390 Ω parallelled by a capacitance of 25 pF. (Other R's and C's are available on request).

4. MAINTENANCE

4.1. Replaceable Parts

For replacement of a defective noise diode see paragraph 4.2. Replacement of all other components, excluding the power cable, should be made at the factory.

4.2. Diode Replacement

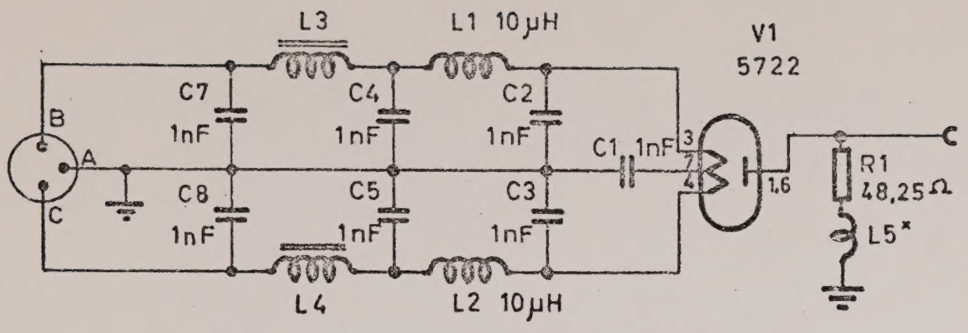
The diode is, when used with Noise Figure Meter Model 113, operated at a low filament voltage. Thus the diode has an extremely long life. If diode replacement is required, open the Noise Source by unscrewing the legs of the source and the screw opposite the legs. The noise diode is then accessible.

4.3. Output Resistance

You may easily measure the output resistance (50 Ω or 390 Ω) of the 123 at the BNC output connector. To check for continuity you may use the ohmmeter section of a vacuum tube voltmeter. To accurately measure the output resistance a Wheatstone Bridge should be used. For the 123 A the resistance should be between 47.8 and 48.7 Ω. For the 123 B the resistance should be within ± 5 %.

4.4. Output VSWR

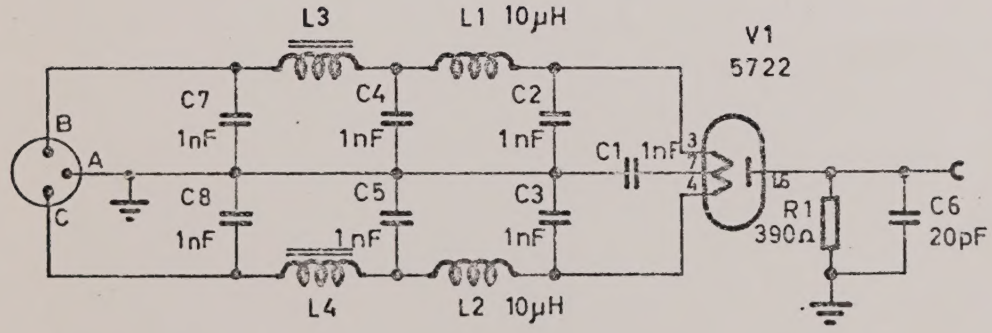
To verify the output VSWR of the 123 A Noise Source connect it to an impedance bridge like the GR Admittance Meter. Measure the VSWR at 150, 200 and 250 Mc/s



* adjusted at factory for optimum source impedance.

* justerad vid tillverkningen för optimal generatorimpedans

Schematic Diagram of Model 123A
Principschema för Modell 123A

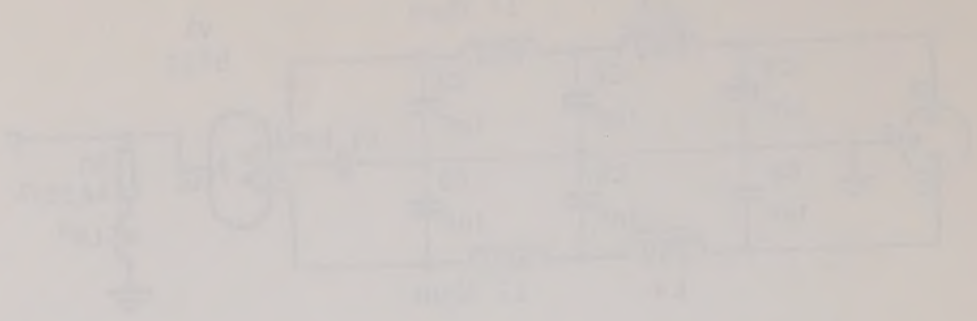


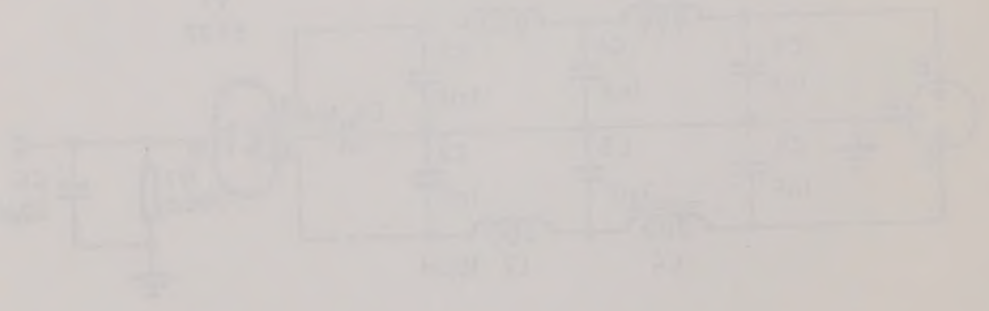
B
19. 3.
69
A
5.12
68

Schematic Diagram of Model 123B
Principschema för Modell 123B

Fig. 3-1 Noise Source Model 123
Fig. 3-1 Bruskälla Modell 123

E-12316





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